



# Model 330 Autotuning Temperature Controller

- Autotuning – eliminates the need for the user to select PID parameters (manual setting mode included)
- SoftCal™ – improves system accuracy with instrument's software and DT-470 diode sensor
- Thermometry
  - Dual sensor input
  - Four-lead sensor measurement
  - Measurement circuitry isolated from digital interface
  - Space for several CalCurves™
- Sensor types
  - Silicon diodes
  - GaAlAs diodes
  - Platinum RTDs
  - Thermocouples
- Control
  - Control stability to  $\pm 2.5$  mK
  - Three term PID control loop
  - Heater output isolated from the measurement circuitry
  - 50 or 25 watt max. heater power
  - Two lower power ranges available in decade steps
- Zone storage of control parameters (PID and heater range)
- Setpoint ramping
- Interfaces
  - Four and one-half digit LED display of sensor temperature in K, °C and sensor units in volts, ohms
  - Continuous display of heater output
  - IEEE-488 interface and serial interface included
- LabVIEW® driver available from National Instruments®



The Model 330 is the perfect choice for the user who wants a full-featured, dual input, easy-to-operate cryogenic temperature controller. The Model 330 offers many desirable features at a lower cost than other temperature controllers.

The Model 330 accommodates three of the most common cryogenic temperature sensors with the flip of a switch (thermocouples optional). These are field selectable, without calibration. Isolated excitation currents allow true four-lead measurement of the sensor signals. High resolution A/D converters digitize the signal at both inputs simultaneously for use in thermometry, control and autotuning.

Precision thermometry is the most basic building block of any digital controller and is necessary for stable, accurate control. Careful analog design and ground isolation provide the Model 330 with stable and repeatable measurements. Accuracy of the Model 330's thermometry can be enhanced with Lake Shore calibrated sensors and CalCurves™ or with the use of SoftCal™ which minimize sensor and measurement errors when using DT-470 silicon diodes.

Software in the Model 330 compares the measured value of the control sensor to the desired control setpoint and acts with the three term (PID) control function to minimize the difference. Control parameters can be entered manually or by the autotuning algorithm. Up to 50 watts of heater power is available to control a variety of cryogenic cooling systems. The power output of the Model 330 is a quiet, variable DC current to ensure as little noise coupling as possible between the heater and experiment. Two lower heater ranges allow for a variety of cooling systems.

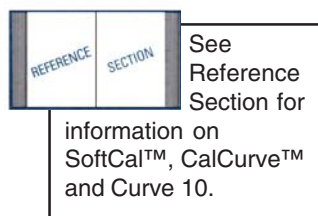
The Model 330 allows up to ten user defined temperature zones to be entered over the interface. Each temperature zone has its own PID and heater range settings. If the setpoint is changed from one zone to another, the PID and heater range settings will change to those entered for the new zone.

The setpoint ramp, settable from 0.1 to 99.9 K/min, allows the user to set the rate at which the setpoint increases or decreases when changed. For example: The setpoint is 50 K and the ramp rate is 1 K/min. The user changes the setpoint to 110 K. The Model 330 will change the setpoint in 0.1 K increments so that in one minute the temperature will reach 51 K and in one hour the temperature will reach its new setpoint of 110 K. The controller automatically changes the PID and heater range as the temperature setpoint passes through the different zones if the setpoint ramp and zone features are used together.

Autotuning is one more step in Lake Shore's commitment to bringing convenience along with performance to the cryogenic measurement and control market. Autotuning utilizes information gathered during setpoint changes to optimize the control parameters.

IEEE-488 and serial interface provide remote access to data and stored parameters in the Model 330 and allow setting of most front panel functions.

A bright, two line LED display shows data from both channels. Percent heater output is always visible on a bar graph. Annunciators give quick visual feedback of channel, units and heater range.



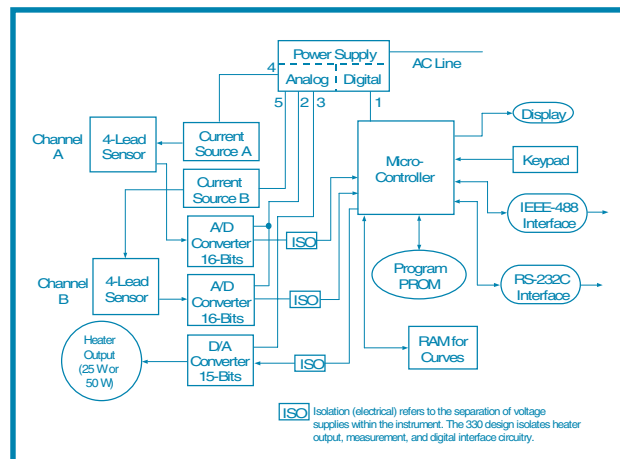
## Sensor Input and Display Performance Chart

Suffix	1	3	2	4 <sup>(1)</sup>
Sensor type	Silicon diode	GaAlAs diode	100 $\Omega$ Platinum RTD	Thermocouple
Sensor temperature coefficient	Negative	Negative	Positive	Positive
Sensor units	Volts (V)	Volts (V)	Ohms ( $\Omega$ )	Millivolts (mV)
Input range	0 – 2.5 V	0 – 6 V	0 – 300 $\Omega$	$\pm 15$ mV
Sensor excitation (constant current)	10 $\mu$ A $\pm 0.1\%$	10 $\mu$ A $\pm 0.1\%$	1 mA $\pm 0.01\%$	Not applicable
Example LSCI sensor	DT-470-SD-13 with 1.4HS calibration	TG-120-SD with 1.4L calibration	PT-103 with 14J calibration	Ch-AuFe 0.07%
Sensor temperature range	1.4 K – 475 K	1.4 K – 325 K	30 K – 800 K	1.4 K – 325 K *
Standard sensor curve	LSCI Curve 10	Requires calibrated sensor and CalCurve™	DIN 43760	NBS/NIST generated <sup>(2)</sup>
Typical sensor sensitivity	-30 mV/K at 4.2 K -1.9 mV/K at 77 K -2.4 mV/K at 300 K -2.2 mV/K at 475 K	-180 mV/K at 4.2 K -1.25 mV/K at 77 K -2.75 mV/K at 300 K	0.19 $\Omega$ /K at 30 K 0.42 $\Omega$ /K at 77 K 0.39 $\Omega$ /K at 300 K 0.33 $\Omega$ /K at 800 K	16 $\mu$ V/K at 4.2 K 20 $\mu$ V/K at 300 K
Measurement resolution				
Sensor units	0.04 mV	0.09 mV	5 m $\Omega$	0.45 $\mu$ V
Temperature equivalence	1.3 mK at 4.2 K 21 mK at 77 K 16 mK at 300 K 18 mK at 475 K	0.5 mK at 4.2 K 72 mK at 77 K 32 mK at 300 K	26 mK at 30 K 12 mK at 77 K 13 mK at 300 K 15 mK at 800 K	30 mK at 4.2 K 22 mK at 300 K
Display resolution and setpoint setting				
Sensor units	0.1 mV < 2 V 1 mV $\geq$ 2 V	0.1 mV < 2 V 1 mV $\geq$ 2 V	0.01 $\Omega$ < 200 $\Omega$ 0.1 $\Omega$ $\geq$ 200 $\Omega$	1 $\mu$ V –
Temperature units	0.01 K < 200 K 0.1 K $\geq$ 200 K	0.01 K < 200 K 0.1 K $\geq$ 200 K	0.01 K < 200 K 0.1 K $\geq$ 200 K	0.01 K < 200 K 0.1 K $\geq$ 200 K
Measurement accuracy – sensor units	$\pm 125 \mu$ V $\pm 0.015\%$ RDG	$\pm 200 \mu$ V $\pm 0.035\%$ RDG	$\pm 12$ m $\Omega$ $\pm 0.04\%$ RDG	$\pm 1.5 \mu$ V + 0.1% RDG
Temperature accuracy with calibrated sensor and 8001 CalCurve™	$\pm 50$ mK at 4.2 K $\pm 120$ mK at 77 K $\pm 80$ mK at 300 K $\pm 75$ mK at 475 K	$\pm 40$ mK at 4.2 K $\pm 350$ mK at 77 K $\pm 150$ mK at 300 K	$\pm 45$ mK at 30 K $\pm 62$ mK at 77 K $\pm 105$ mK at 300 K $\pm 235$ mK at 800 K	$\pm 406$ mK at 4.2 K <sup>(2)</sup> $\pm 110$ mK at 300 K
Measurement temperature coefficient				
Sensor units (%reading/ $^{\circ}$ C ambient)	$\pm 0.002\%/^{\circ}$ C	$\pm 0.004\%/^{\circ}$ C	$\pm 0.006\%/^{\circ}$ C	$\pm 0.01\%/^{\circ}$ C
Temperature equivalence	$\pm 2$ mK/ $^{\circ}$ C at 4.2 K $\pm 20$ mK/ $^{\circ}$ C at 77 K $\pm 6$ mK/ $^{\circ}$ C at 300 K $\pm 2$ mK/ $^{\circ}$ C at 475 K	$\pm 2$ mK/ $^{\circ}$ C at 4.2 K $\pm 50$ mK/ $^{\circ}$ C at 77 K $\pm 15$ mK/ $^{\circ}$ C at 300 K	$\pm 2$ mK/ $^{\circ}$ C at 30 K $\pm 4$ mK/ $^{\circ}$ C at 77 K $\pm 20$ mK/ $^{\circ}$ C at 300 K $\pm 60$ mK/ $^{\circ}$ C at 800 K	30 mK/ $^{\circ}$ C at 4.2 K 20 mK/ $^{\circ}$ C at 300 K
Control stability	$\pm 2.5$ mK at 4.2 K $\pm 25$ mK at 77 K $\pm 25$ mK at 300 K	$\pm 5$ mK at 4.2 K $\pm 50$ mK at 77 K $\pm 50$ mK at 300 K	$\pm 15$ mK at 30 K $\pm 15$ mK at 77 K $\pm 15$ mK at 300 K $\pm 25$ mK at 800 K	$\pm 40$ mK at 4.2 K $\pm 40$ mK at 300 K
Magnetic field use	Recommended T $\geq 60$ K and B $\leq 3$ T	Recommended T $\geq 4.2$ K and B $\leq 5$ T	Recommended T $> 40$ K and B $\leq 2.5$ T	Type dependent

(1) All thermocouple data is for uncompensated inputs.

(2) Sensor calibration and 8001 CalCurve™ are not available for thermocouples. The error listed is for the instrument only.

The performance chart identifies the input configurations possible with this instrument. System performance with any of the inputs depends greatly on sensor characteristics. Much of the typical data presented here is based on the Lake Shore sensor listed in each column. Other sensors of the same type can be used with the instrument. Similar performance can be expected if the sensor sensitivities match.



\* High temperature versions are available. Please consult Lake Shore for more information.

## Specifications

### Thermometry

Number of inputs: Two

Measurement type: Four-lead isolated

Sensor type: Silicon diode, GaAlAs diode, Platinum

Optional sensor types: Thermocouple (factory only)

Accuracy: Based on configuration (see chart on the previous page)

Update rate: Both channels in 1 second

Standard curves: Curve 10, DRC-D, DRC-E1, DIN 43760, Type E, Type K, Type T, AuFe 0.07%, AuFe 0.03%

Precision curve storage: Room for 20, 31-point curves

SoftCal™: Improves system accuracy to  $\pm 0.25$  K from 30 K to 375 K with DT-470 diode sensor entered in voltage or temperature. See Reference Section.

### Control

Control type: Digital, three term PID with autotuning

Control stability: Based on configuration (see chart on the previous page)

Setpoint setting resolution: See chart on previous page

Control sensor selection: Front panel

Heater output type: Variable DC current source

Heater setting resolution: 15 bits

Max power to heater: 25 watts/50 watts (field configurable)

Max current to heater: 1 A

### Heater current and power by range:

Range	I <sub>max</sub>	Power <sup>(1)</sup>	Power <sup>(1)</sup>
High	1 A	50 W/50 $\Omega$	25 W/25 $\Omega$
Med	0.3 A	5 W/50 $\Omega$	2.5 W/25 $\Omega$
Low	0.1 A	0.5 W/50 $\Omega$	0.25 W/25 $\Omega$

Heater output compliance: 50 V 25 V

Heater load for full power: 50  $\Omega$  25  $\Omega$

Minimum heater load: 35  $\Omega$  10  $\Omega$

Heater noise: 50  $\mu$ V + 0.01% of output voltage<sup>(2)</sup>

Ramp rate: 0.1 to 99.9 K/min

Control zones: Ten (10) configured by interface

### Front Panel

Sensor display: Two, 4 1/2 digit LED

Setpoint display: Shared with control sensor

Display units: Temperature K, °C; sensor units V,  $\Omega$ , mV

Heater output display: 20 digit LED bar graph, percent of full scale current for range

Annunciators: Channel, units, heater range, interface mode

Temperature display resolution: 0.01 below 200, 0.1 above

Sensor units resolution: See Sensor Input and Display Chart on the previous page

Keypad: Numeric plus special function

### Interfaces

IEEE-488 capabilities: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0, E1

Serial: 300 or 1200 baud, RJ11 connector, RS-232C electrical standard

### General

Ambient temperature range: 15 - 35 °C (59 - 95 °F) to specified accuracy

Power requirements: 100, 120, 220, 240 VAC (+5%-10%); 50 or 60 Hz; 135 VA

Enclosure type: Half rack

Size: 216 mm wide x 90 mm high x 419 mm deep (8.5" x 3.5" 16.5")

Weight: 5 kg (11 lb)

Approval: CE Mark



Model 330 rear panel

- 1 - Line Input Assembly
- 2 - IEEE-488 Interface
- 3 - Serial Interface
- 4 - Sensor Inputs
- 5 - Heater Output

### 3003 Heater Output Conditioner

The heater output conditioner is a passive filter which further reduces the already low Model 330 heater output noise. The typical insertion loss for the Model 3003 is 20 dB at or above line frequency, and >40 dB at or above double line frequency. A 144 mm x 72 mm x 165 mm (5.67" x 2.84" x 6.5") panel mount enclosure houses this option, and it weighs 1.6 kg. (3.5 lbs.)



## Ordering Information

The Model 330 has two independent sensor inputs that can be configured with any two of the following input types. Please note that the user can reconfigure any of the first three input types. The optional thermocouple input cannot be reconfigured by the user. There is an additional cost associated with the thermocouple input.

Input Type	Suffix
Silicon diode	1
Platinum	2
GaAlAs diode	3
Thermocouple	4

For ordering, add two suffixes in any combination (putting the lower number first) to specify input type (e.g., 330-12 for a Model 330 with one silicon diode input and one Platinum input). The standard Model 330 heater output is 25 watts. An additional suffix of W50 should be added to the order number to have the factory configure the unit for 50 watts operation or the user can do so by moving a jumper within the unit.

### Model number

330-11	Silicon diode/Silicon diode
330-12	Silicon diode/Platinum
330-13	Silicon diode/GaAlAs diode
330-22	Platinum/Platinum
330-23	Platinum/GaAlAs diode
330-33	GaAlAs diode/GaAlAs diode
330-41	Thermocouple/Silicon diode
330-42	Thermocouple/Platinum
330-43	Thermocouple/GaAlAs diode
330-44	Thermocouple/Thermocouple

The standard Model 330 heater output is 25 watts. An additional suffix of W50 should be added to the order number to have the factory configure the unit for 50 watts operation.

Please specify AC line voltage requirement (100, 120, 220 or 240 VAC).

### Accessories included

115-006	Detachable 120 VAC line cord
106-233	Sensor mating connector. 6-pin DIN plugs used for sensor inputs
106-009	Heater output connector (dual banana jack)
MAN-330	User's manual

### Options

8001	CalCurve™, Factory Installed. Consists of the breakpoint table from a calibrated sensor stored in the instrument.
8002-05	CalCurve™, Field Installed. Consists of the breakpoint table from a calibrated sensor loaded into a nonvolatile memory for customer installation.

### Accessories available

#### Adapters

2002	RJ11 to DB-25 adapter. Adapts RJ11 receptacle to female DB-25 connector. Connects Model 330 to customer computer rear RS-232C serial port.
2003	RJ11 to DE-9 adapter. Adapts RJ11 receptacle to female DE-9 connector, connects Model 330 to customer computer rear RS-232C serial port.

#### Cables

2001	RJ11 Cable assembly. Four-wire cable assembly with RJ11 plugs on each end. Used with RS-232C interface. Cable is 4.6 m (14') long.
8072	IEEE-488 computer interface interconnect cable assembly. 1 m (3.3') long
8271-30	Sensor/heater cable assembly for diode and platinum sensors

#### Rack mount kits

RM-1/2	<b>Rack Mount Kit</b> For mounting one 1/2 rack temperature controller in 482.60 mm (19") rack
RM-2	<b>Rack Mount Kit</b> For mounting two 1/2 rack temperature controllers in 482.60 mm (19") rack

#### Heaters

HTR-25	25 $\Omega$ cartridge heater, 25 W, 6 mm (1/4") dia x 25.4 mm (1") long
HTR-50	50 $\Omega$ cartridge heater, 50 W, 6 mm (1/4") dia x 25.4 mm (1") long
HTR-25-100	25 $\Omega$ , 100 W cartridge heater
3003	Heater output conditioner

